5.3.3 Damping

	Learning outcomes	Additional guidance
	Learners should be able to demonstrate and apply their knowledge and understanding of:	
(a)	free and forced oscillations	
(b)	(i) the effects of damping on an oscillatory system	HSW9, 12
	(ii) observe forced and damped oscillations for a range of systems	
(c)	resonance; natural frequency	HSW9, 12
(d)	amplitude-driving frequency graphs for forced oscillators	
(e)	practical examples of forced oscillations and resonance.	HSW9, 12

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(6) M - Describe practical and real life examples of resonance
(7) S - Describe examples where resonance is useful or unwanted
(8) C - Describe graphically how the amplitude of a forces oscillation changes with frequency near to natural frequency of the system

Resonance

STARTER: What is resonance? Driver f

Take in SHM hwk

Natural f.

Extension: Resonance is useful. Discuss

resonance The increase in amplitude of a forced oscillation when the driving frequency matches the natural frequency of the oscillating system

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Activity. First, how do you find the natural frequency of an oscillating system?

Method

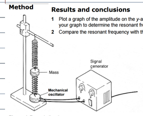


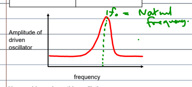
Figure 1 *Forced vibrations*

1. Set up the oscillating system as shown in Figure 1. Use the second clamp and stand to hold the metre rule.
2. Make measurements to determine the natural frequency of the oscillating system.
3. Use a variable frequency signal generator to alter the frequency of the vibrations applied to the system.
4. Note any change in the amplitude of the oscillations. Measure the maximum amplitude of the oscillations.
5. Repeat the measurement for different frequencies at and either side of the resonant frequency.

Results and conclusions

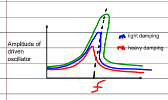
1. Plot a graph of the amplitude on the *y*-axis against the applied frequency. Use your graph to determine the resonant frequency of the system.
2. Compare the resonant frequency with the natural frequency of the oscillations.

Driving Frequency (Hz)	Max Amplitude (m)



How could you damp this oscillation.

What affect would damping have on the amplitude/frequency of the oscillation?



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0:00:00

Describing resonance.

For resonance to occur the system must be free to oscillate and be forced to oscillate using a driving force.

energy

Activity:

Sequence how resonance occurs in this forced oscillator. You must describe what changes occur at resonance.

Driving force frequency = natural frequency of mass on spring → Energy is transferred from driver to mass in same phase each oscillation → Energy transfer from driver to mass is maximised → **Amplitude** increases dramatically. Is maximum

Important

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Examples of resonance wine glass millennium bridge 0:00:00

Example	What is oscillating?	What creates the driving force?	Effect of the resonance

Ex: How could you reduce the amplitude in each case (damping)?

Examples of resonance

As well as causing a problem for engineers designing buildings and bridges, resonance can have useful effects:

- Many clocks keep time using the resonance of a pendulum or of a quartz crystal:
- Many musical instruments have bodies that resonate to produce louder notes.
- Some types of tuning circuits (for example in car radios) use resonance effects to select the correct frequency radio wave signal.
- Magnetic resonance imaging (MRI) enables diagnostic scans of the inside of our bodies to be obtained without surgery or the use of harmful X-rays.

Use old book as source

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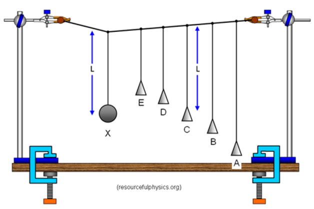
Barton's pendulum 0:00:00



Sketch the setup.
Explain how the Barton's pendulum can be used to explain resonance in terms of **phase and energy**.

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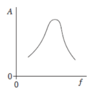
Plenary

A periodic force is applied to a lightly-damped object causing the object to oscillate.
The graph shows how the amplitude A of the oscillations varies with the frequency f of the periodic force.



Which one of the following statements best describes how the shape of the curve would differ if the damping had been greater?

A the curve would be lower at all frequencies

B the curve would be higher at all frequencies

C the curve would be unchanged except at frequencies above the resonant frequency where it would be lower

D the curve would be unchanged except at frequencies above the resonant frequency where it would be higher

(Total 1 mark)

A

Which one of the following statements about an oscillating mechanical system at resonance, when it oscillates with a constant amplitude, is **not** correct?

A The amplitude of oscillations depends on the amount of damping.

B The frequency of the applied force is the same as the natural frequency of oscillation of the system.

C The total energy of the system is constant.

D The applied force prevents the amplitude from becoming too large.

(Total 1 mark)

D

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